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### INTRODUCTION.

This REVIEW treats generally the meteorological conditions of the United States and Canada for November, 1887, and is based upon the reports of regular and voluntary observers of both countries. Descriptions of the storms that occurred over the north Atlantic Ocean are also given, and their paths shown on chart i, on which also appear the limits of fog-belts west of the fortieth meridian. No ocean ice has been reported.

East of the Mississippi River and on the north Pacific coast the temperature was about normal, but in all districts west of the ninety-fifth meridian, except the north Pacific coast, the month was decidedly warmer than the average, the departures from the normal temperatures amounting to from 4° to 6° in the central and southern Rocky Mountain districts.

The rainfall in general was below the average in all parts of the country, the deficiency being greatest in the east Gulf states, where the rainfall was only about 15 per cent. of the normal.

Some special data in connection with the deficiency of rainfall during the period from March to November, 1887, is given under the heading "Drought," from which it is shown that over an extensive area the rainfall of the period mentioned is less than 60 per cent. of the normal.

Chart iii formerly issued with the REVIEW has been discontinued, and will not therefore appear in future REVIEWS.

A new chart (similar to number v of the REVIEW for July, 1887), numbered iii, accompanies this issue.

In the preparation of this REVIEW the following data, received up to December 20, 1887, have been used, viz., the regular tri-daily weather-charts, containing data of simultaneous observations taken at 133 Signal Service stations and 23 Canadian stations, as telegraphed to this office; 170 monthly journals and 168 monthly means from the former and 23 monthly means from the latter; 268 monthly registers from voluntary observers; 60 monthly registers from United States Army post surgeons; marine records; international simultaneous observations; marine reports through the co-operation of the "New York Herald Weather Service;" monthly weather reports from the local weather services of Alabama, Illinois, Indiana, Kansas, Louisiana, Michigan, Missouri, Nebraska, New England, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, and Tennessee, and the Central Pacific Railway Company; trustworthy newspaper extracts, and special reports.

### ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean pressure for November, 1887, determined from the tri-daily telegraphic observations of the Signal Service, is shown by isobarometric lines on chart ii.

As to the region covered by the area of greatest mean pressure, the November chart is similar to that for the preceding month, and it may be said that the general distribution of pressure for November does not materially differ from that for October, the range (.27) in the monthly means being considerably less than during the two preceding months. From the area of barometric maxima, which covers portions of the middle and southern plateau regions, the gradient is steepest to the northward and northwestward, the mean pressure at Olympia, Wash., being 30.01, and at Calgary, British Northwest Territory, 29.98; the decline of pressure is least to the southeastward, the barometric means falling to slightly below 30.1 over the eastern Rocky Mountain slope, and thence increasing to 30.16 at Knoxville, Tenn. While the region of least mean pressure for October was a part of the southern plateau, that for the current month is the Gulf of Saint Lawrence and the Canadian provinces to the westward. The barometric means of November, compared with those of the preceding month, show an increase over nearly the whole country, the exception being the region extending from Dakota westward to the Pacific coast (where deficiencies occur) and the central Mississippi and lower Ohio valleys (where no change is shown). The deficiency is greatest on the north Pacific coast, and the greatest excesses are in the southern plateau and portions of the south Atlantic and east Gulf states, the extreme departures being: Olympia, Wash., .17 deficiency; and Cedar Keys, Fla., and Yuma, Ariz., excess .11 and .12, respectively.

The departures from the normal pressure for the various stations are given in the table of miscellaneous meteorological data. The mean pressure of the current month so nearly corresponds with the normal that there is but one comparatively small area, embracing portions of the lower lake region, New England, and the middle Atlantic states, over which the departures (deficiencies) amount to or exceed .05. The extreme departures are: deficiency, New London, Conn., .08; excess, La Crosse, Wis., .04.

### BAROMETRIC RANGES.

The monthly barometric ranges at the various Signal Service stations are also given in the table of miscellaneous meteorological data. The ranges, as usual, conform to the general rule, that is, they increase with the latitude and decrease slightly, though somewhat irregularly, with increasing longitude. A comparison of the barometric ranges of the current month with the November normal ranges shows no marked contrast, except over the region extending from Minnesota eastward to the New England coast where they are much greater than usual, the departure in the upper lake region amounting to about .50. In the states bordering on the Atlantic the extreme ranges are, .32 at Key West, Fla., and 1.76 at Portland, Me.; over the interior of the country, .48 at Galveston, Tex., and 1.77 at Escanaba, Mich.; on the Pacific coast, .45 at San Diego, Cal., and 1.09 at Port Angeles and Tatoosh Island, Wash.

### AREAS OF HIGH PRESSURE.

Six areas of high pressure were observed within the limits of territory covered by the daily weather charts during the month of November. Two of these areas apparently ap-

proached the north Pacific coast from the west and crossed the continent, moving in a southeasterly direction. Three were first observed at the northern Rocky Mountain stations, two of which passed directly east, the centre of greatest pressure remaining near the fiftieth parallel, and the third passed first over the eastern Rocky Mountain slope and thence eastward from Kansas to the Saint Lawrence Valley. The sixth area of high pressure observed apparently developed near Lake Superior and descended southward over the eastern portion of the United States, the greatest direction of movement being to the southeast.

The following is a description of the areas of high pressure observed, and the general weather conditions attending each:

The month opened with northeasterly gales along the middle Atlantic and New England coasts. These gales resulted from a disturbance traced as an ocean storm and partially described in the October REVIEW, and the advance of the accompanying area of high pressure which covered the Saint Lawrence Valley and the lower lake region on the 1st. This area of high pressure extended southward to the Gulf and south Atlantic states, attended by generally fair weather during the first week of the month over the greater portion of the United States.

I.—This high area appeared on the north Pacific coast on the 2d, but it had been preceded by high barometric readings in the Rocky Mountain and plateau regions. It was well defined on the morning of the 4th, central in western Nebraska, moving slowly to the southeast in the rear of a cyclonic disturbance then covering the upper Saint Lawrence valley. By the morning of the 5th this area of high pressure extended over the central valleys, the pressure having decreased slightly within both the high and low areas referred to above, while the easterly movement of each had been approximately nine hundred miles during the preceding twenty-four hours. This area extended over the eastern portion of the country on the 5th, the line of greatest pressure coinciding nearly with the twenty-fifth parallel, and it was last observed off the North Carolina coast on the 7th.

II.—On the morning of the 7th this area of high pressure was apparently forming in the upper Missouri valley, and the weather chart of that date showed that a disturbance had formed rapidly over the western portion of Lake Superior. This high area moved directly east, attended by increasing pressure at the centre, and the depression above referred to showed a corresponding increase of pressure until its centre had passed to the northeast of the Maritime Provinces. The barometer rose over New England and the middle Atlantic states during the 9th, after which this area disappeared, owing to the advance of a storm then moving northeast over the Lake region.

III.—The a. m. tri-daily weather chart of the 11th shows a cyclonic disturbance of great energy central on the coast of Maine, the barometer at Eastport being 29.14, while the pressure ranged from 30.20 to 30.24 in the vicinity of Lake Superior. Reports on this and the preceding charts indicate that this area formed over the upper lake region. The pressure increased over the eastern half of the United States during the 12th, the line of greatest pressure extending from Lake Superior to Virginia, thus making an angle of about 90° with the track of the centre of the preceding low area. It became more extended as it approached the coast, and the pressure diminished about .2 during its southeasterly movement.

IV.—The barometer remained generally above the normal on the north Pacific coast from the 15th to the 20th, during which time this area was gradually extending eastward over the Rocky Mountains and central valleys. On the morning of the 20th the barometer was highest over the central plateau regions, but this area was clearly defined over northern Texas. After the 20th the pressure diminished west of the Rocky Mountains, and that portion over Texas moved first southward and then eastward along the Gulf coast, attended by the lowest observed temperature of the month on the east Gulf coast and

in northern Florida. Killing frosts occurred at Pensacola and Jacksonville on the morning of the 21st, while this area was central over Alabama. The pressure increased as it approached the coast, the barometer reading 30.20 while it was central over Texas, and 30.40 when it was last observed east of Hatteras.

V.—This high area appeared north of Montana on the 21st and extended eastward over the northern portion of the United States, the centre remaining to the north of the Lakes and the Saint Lawrence Valley, and the pressure increasing during the easterly movement, the barometer having risen to 30.60 and above at the extreme northeast stations. The most marked changes in temperature during the passage of this high area occurred in the lower Missouri and central Mississippi valleys, but these changes were not sufficient to justify a portion of the cold-wave signals displayed in advance of it.

VI.—This area appeared in the northern Rocky Mountain region on the 24th, and after remaining almost stationary for twenty-four hours it passed southward over the Missouri Valley, attended by the most severe cold wave of the month. The temperature fell below —30° in Manitoba, and to —24° at North Platte, Nebr., on the 27th, when the barometer was highest in Kansas. At many stations in the central valleys the temperature fell from 30° to 50° in twenty-four hours. A severe "norther" occurred in Texas and Indian Territory, for which the railroads in the Southwest generally received timely warning. The track of the centre of this area of high pressure extended from north of northern Montana to western Kansas and thence eastward to Lake Erie, after which it passed northward of the Lake region, where this area was re-enforced, thus forming the most extended area of high pressure observed during the month, and within which were observed the maximum barometric readings at stations in the Saint Lawrence Valley recorded during the past fifteen years.

The a. m. chart of December 1st shows a well-marked high area, bounded by an isobar of 31.10, over the region named above, and all stations east of the Rocky Mountains were included within the limits of this barometric condition.

#### AREAS OF LOW PRESSURE.

Ten areas of low pressure were observed within the limits of the United States or adjoining territories during the month of November. The mean latitude of the tracks of the centres of these areas of low pressure was slightly to the north of the mean storm tracks for November. Of the ten disturbances traced on chart number i six probably developed to the east of the Rocky Mountains, and five were attended by secondary depressions which developed in the southern quadrants of the principal depressions. The most severe storms of the month resulted from secondary disturbances which developed south of New England while the principal disturbance was central in the Saint Lawrence Valley. During the month no barometric depression passed over the south Atlantic states, Ohio Valley, or the middle Atlantic states south of New York.

The following table shows the latitude and longitude in which each area was first and last observed, and the average hourly velocity in miles per hour:

Number of area.	First observed.		Last observed.		Average hourly velocity.
	Lat. N.	Long. W.	Lat. N.	Long. W.	
I.....	52 00	98 00	52 00	69 00	43.0
II.....	47 00	99 00	50 00	65 00	36.0
III.....	52 00	99 00	51 00	83 00	43.0
IIIa.....	47 00	90 00	50 00	70 00	50.0
IV.....	39 00	92 00	47 30	72 00	32.0
IVa.....	41 30	71 00	45 00	66 00	17.0
V.....	50 00	109 00	44 00	77 00	27.0
Va.....	40 00	72 00	47 00	65 00	27.0
VI.....	44 00	103 00	47 00	79 00	32.0
VII.....	50 00	102 00	47 00	70 00	38.0
VIII.....	53 00	110 00	52 00	90 00	28.0
VIIIa.....	45 00	107 00	37 00	95 00	28.0
IX.....	36 00	91 00	43 00	84 00	30.0
X.....	39 00	91 00	49 00	67 00	33.0

Average rate of progress, 33.0 miles per hour.

I.—This area of low pressure was central north of Manitoba on the morning of the 1st, the barometer near the centre being 29.74, and at the same report the depression previously described as an ocean storm was central off the middle Atlantic coast, attended by severe northerly gales at coast stations between Hatteras, N. O., and Boston, Mass. The depression traced as number i for the current month passed rapidly eastward, the centre remaining north of the stations of observation, without causing any marked change in the weather conditions within the limits of the United States. It was last observed in the Saint Lawrence Valley on the 2d, when the central area became much extended and the disturbance apparently decreased in energy.

II.—This low area apparently formed in the upper Missouri valley, where it was central at the 10 p. m. report of the 2d; it moved slowly eastward, inclining slightly southward during the 3d, and passed over the Lake region with increasing energy; the barometric pressure at the centre diminished from 29.9 to 29.28 during the passage of this area from Dakota to the lower Saint Lawrence valley, where the principal disturbance attending this condition was central on the afternoon of the 4th, attended by westerly gales in the Lake region and on the New England coast. The maximum force of the wind attending this storm probably occurred during the 4th, as the pressure was rising near the centre of disturbance when last observed passing to the east of the Maritime Provinces. The central area was almost circular in form until it reached the lower Saint Lawrence valley, after which the isobars for southern quadrants extended southward along the Atlantic coast, forming an elongated depression within which the winds attained dangerous velocities from the south, quickly shifting to westward as the storm-centre advanced.

III.—This disturbance probably developed in the northern Rocky Mountain region or on the north Pacific coast, but its centre was first located on the tri-daily weather chart to the north of Manitoba on the morning of the 6th, the reports for the preceding day indicating unusually low barometric pressures to the north of Dakota and Montana. It passed eastward during the succeeding twenty-four hours as an extended depression whose centre was far to the north of the stations of observation, but the area of high pressure then covering the Atlantic coast districts caused an increasing barometric gradient in the Lake region, attended by brisk and high south-westerly winds. The principal disturbance could not be traced farther to the eastward than the eighty-second meridian, but a secondary disturbance developed over the west portion of Lake Superior during the night of the 6th and moved directly eastward, following the general course of the Saint Lawrence Valley, causing the westerly gales to continue during the 7th in the upper lake region, and during the 8th in the lower lake region and Saint Lawrence Valley.

IV.—This storm partially developed in the southwest during the 8th, but it became defined as a cyclonic disturbance in the central valleys on the morning of the 9th, when the tri-daily weather chart exhibited areas of high pressure central over the Saint Lawrence Valley and the Rocky Mountain region, and as the disturbance passed eastward during the 9th general rains occurred over the drought region and the area of precipitation extended eastward, including all states east of the Mississippi. The winds increased in force as the storm passed over the Lake region, the depression being circular in type while passing over the lower lake region, with an apparent tendency to pass into an elongated or loop-shaped type in the southern quadrants. The primary disturbance was distinctly traced to the lower Saint Lawrence valley, while a secondary depression formed suddenly on the southern New England coast during the night of the 10th, developing great energy along the New England coast, where the pressure diminished from 30.1 to 29.1 at Eastport, Me., during the twenty-four hours ending at 7 a. m. of the 11th. The gales attending this secondary depression were of unusual severity, the wind reaching a maximum velocity of fifty miles per hour at Eastport on the 11th; the gradient and

winds also increased to the westward over the lower lake region during the same day. The storm was central near Eastport on the afternoon of the 11th, when the pressure was increasing at the centre. It passed to the eastward of the coast stations and continued its easterly course as an ocean storm, the centre of which is traced as number 8 on chart i.

V.—The tri-daily weather charts of the 10th and 11th show that a barometric depression passed over the north Pacific coast, but it was not possible to definitely trace this disturbance to the west of the one hundred and tenth meridian. It was observed north of Montana on the 12th, the isobars bounding the centre trending to the southeastward, covering the greater portions of the Missouri Valley. It passed eastward, attended by light rains, during the 13th, and after reaching the longitude of Lake Superior it was apparently drawn south-eastward over the Lake region. The pressure remained about stationary at the centre of this disturbance during its transit from north of Montana to near Lake Erie, where it disappeared, a secondary disturbance forming during the night of the 14th on the southern New England coast. As in the preceding storm on this coast, this disturbance moved northward, following the general direction of the coast line, causing severe gales and heavy rains, with snow in the interior. It continued its course to the northeast over the Maritime Provinces, but after passing over New England the barometric gradient diminished, and although gales were reported the storm lost force and the central area became greatly extended.

VI.—The afternoon report of the 15th exhibited a trough-shaped depression covering the eastern slope of the Rocky Mountains, within which the centre of lowest pressure was located in southeast Dakota. This condition moved slowly eastward, covering the Missouri and Mississippi valleys, without causing any marked change in the weather conditions, the centre of disturbance passing over Nebraska, Iowa, Illinois, and to southern Michigan, where it was located on the afternoon of the 16th. Fair weather continued generally throughout the United States during the passage of this depression, which disappeared to the northeast of Lake Huron, after which it apparently formed a part of the area of low pressure then covering the Gulf of Saint Lawrence.

VII.—This area of low pressure was first observed north of Dakota on the 18th when an area of high barometer extended from the north Pacific coast southeastward to the Ohio Valley, and the barometer was unusually low from the northern Rocky Mountains eastward to the Saint Lawrence Valley. The pressure at the centre of this depression diminished as it moved southeastward to the Lake region, where it was central near Duluth, Minn., the barometer reading 29.26. It continued its southeasterly course during the 19th, passing over lower Michigan, where the minimum pressure, 29.14, was observed at Grand Haven, and the centre was near that station on the afternoon of the 19th. This disturbance extended to the eastward over New England, becoming greatly elongated, but the strongest winds occurred in the west quadrants, attended by a cold wave which extended over the central valleys. The direction of movement of this disturbance changed from southeast to northeast when the centre was near Lake Huron, and it disappeared, following the general course of the Saint Lawrence Valley, during the 20th.

VIII and IX.—When the preceding disturbance extended over the lower Saint Lawrence valley number viii was observed moving eastward from the region north of Montana. At the same time slight areas of high pressure extended over the lower Mississippi valley and central Rocky Mountain stations. This area moved eastward, inclining towards the upper lake region, attended by light snows at northern stations, and after reaching the ninetieth meridian a secondary depression developed in the upper Missouri valley, which was apparently forced to the southward by the advance of an area of high pressure and a cold wave from the north. The primary disturbance disappeared to the northeast of Lake Superior on the 21st, and the secondary depression disappeared by a gradual

increase of pressure, after being forced southward to Kansas and northern Texas.

Although the disturbance traced as number ix formed in the central Mississippi valley, within the barometric trough which separated the area of high pressure to the north and that which extended over the south Atlantic coast, heavy rains occurred over the states in the Ohio, Mississippi, and lower Missouri valleys during the 23d and 24th. This area of low pressure moved northward to southern Michigan, where it disappeared, by an increase of pressure, on the 25th.

X.—The tri-daily weather charts of the 25th exhibited an extensive area of low pressure covering the central and southern plateau regions and extending southeastward to Texas, and from this region a barometric trough extended northeast-

ward to the Lake region. The most decided cold wave of the month was moving rapidly southward over the Rocky Mountain stations and the Missouri Valley, and the cold air from this area of high pressure apparently replaced the area of low pressure to the westward, and the barometric trough to the eastward was followed by an elliptical area of low pressure extending from Arkansas to northern Michigan, and this was followed by a normal area of low pressure over the Saint Lawrence Valley, which disappeared on the 28th to the east of the stations of observation.

The snow and rain attending this disturbance was apparently caused by sudden changes of temperature due to the advance of a cold wave, the range of temperature amounting to from 40° to 50°.

#### NORTH ATLANTIC STORMS FOR NOVEMBER, 1887.

[Pressure in inches and millimetres; wind-force by Beaufort scale.]

The paths of the depressions that have appeared over the north Atlantic Ocean during the month are determined from international simultaneous observations furnished by captains of ocean steamships and sailing vessels; reports received through the co-operation of the "New York Herald Weather Service," and the Hydrographic Office, U. S. Navy; and from other miscellaneous data received to December 21, 1887.

Fourteen depressions are traced, of which two are continuations of storms charted for October, 1887; three traversed the ocean from coast to coast; one first appeared east of the fifteenth meridian; five passed eastward over, or to the northward of, Newfoundland; one apparently originated south of Nova Scotia, and three are given probable paths northward from the sub-tropical region. The general direction of movement of the depressions was east-northeast, and their tracks were rather evenly distributed along, and north of, the trans-Atlantic routes. The first decade of the month was characterized by severe weather over the entire ocean north of the fortieth parallel. During the second decade stormy weather continued to the westward of the thirtieth meridian until the 16th; after which the passage of two areas of low pressure southeastward over the British Isles was accompanied by unsettled meteorological conditions until the 22d. From the 10th to the 12th, inclusive, a depression advanced northeastward in the vicinity of the Azores. During the third decade of the month the barometer rose slowly over the British Isles from the 22d to the 24th, after which storms of moderate force prevailed until the 30th, when the barometer rose rapidly, with light to fresh westerly winds and fair weather; over the ocean west of the thirtieth meridian settled weather and high pressure prevailed in the trans-Atlantic routes, except from the 23d to the 25th, inclusive, while to the southward of the thirtieth parallel two depressions appeared on the 29th and 30th.

In November, 1886, twelve depressions were traced, the tracks predominating east of the forty-fifth meridian, with a general north of east direction of movement. The general character of the weather over the north Atlantic was exceedingly severe, and terrific westerly gales, with tremendous seas, were reported during the first half of the month. Violent storms, occasioned by barometric depressions which passed over the eastern portion of the United States without advancing beyond the coast line, were experienced in the Maritime Provinces and over the ocean west of the sixtieth meridian. The first, and a portion of the second, decades of the month were marked by storms of great violence over the British Isles and adjacent waters. For the first decade five depressions were traced; for the second, three, and for the third, four.

In November, 1887, the month opened with low barometric pressure and gales over the entire ocean, except in the vicinity of the Azores, where the barometer ranged high. Over the eastern portion of the ocean the weather was particularly severe, the British Isles and the west-central European coast being swept by hurricanes, causing great loss of life and de-

struction of property. Along the middle Atlantic and New England coasts, and over the Canadian Maritime Provinces, heavy northerly gales prevailed on the 1st, during which many sailing vessels were damaged or driven ashore. From the 1st to the 5th, inclusive, heavy gales continued east of the fortieth meridian, with barometric minima ranging below 29.00 (736.6). From the 6th to the 14th the weather was comparatively settled over the British Isles, while in the vicinity of Newfoundland there was a succession of gales of moderate strength. During this period the barometric pressure in the vicinity of the Azores was generally low and fluctuating. From the 15th to the 21st the passage of depressions northeastward along the middle Atlantic and New England coasts caused unsettled weather south of Nova Scotia and Newfoundland; over mid-ocean the pressure continued high; over the British Isles the barometer fell rapidly during the 17th, and continued low until the 22d, attending the passage of two areas of low pressure. During the last ten days of the month high barometer and fair weather prevailed along the American coast south of the fiftieth parallel; over the ocean east of Newfoundland fair weather and rising barometer followed the passage of a depression which advanced to the northward of the British Isles during the 27th. No storms appeared in the tropical or sub-tropical regions until the last two days of the month, when the presence of depressions, one to the northward of the West Indies and the other to the southwestward of the Azores, was indicated.

The following are descriptions of the depressions traced:

1.—This depression was a continuation of ocean storm number 16 traced for October, 1887, and, as an apparent subsidiary development to depression number 14 charted for that month, closely followed the latter in its passage over the British Isles. At 12 noon on the 1st this storm was central west of Ireland, with barometric pressure below 28.40 (721.3). By the 2d it had apparently moved eastward over the North Sea beyond the region of observation. The disturbances attending this depression caused an immense amount of damage to property, and many lives were lost by the foundering or going ashore of vessels. The following reports indicate the character of weather encountered off the coasts of the British Isles: Capt. G. Franck, of the s. s. "Australia," reports a hurricane on the 1st; wind veered from se. on October 31st to nw. during November 1st; lowest barometer, 28.38 (720.8), at 2 a. m. of the 1st, in N. 49° 47', W. 8° 45'. Capt. W. A. Beynon, of the s. s. "Belgenland," reports a westerly storm on October 31st and November 1st; lowest barometer, 28.32 (719.3), at 1.30 a. m. of the 1st, in N. 50° 15', W. 10° 12'. The storm was marked by squalls of hurricane force.

2.—This depression was a continuation of ocean storm number 15 charted for October, 1887, and is traced from off the American coast, in N. 37°, on the 1st, to the French coast by the 6th. The depression increased in energy until the 5th, when central west of Ireland, after which it moved east-south-